EVALUATION OF DIFFERENT TECHNIQUES FOR GENERATING LANDSLIDE SUSCEPTIBILITY MAP

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”Dedicated to my wife and my beloved family"

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ABSTRACT

Landslide is a complex natural phenomenon, which may cause loss of lives and properties around the world. In Iran, for example, most landslide occurrences are shallow, and mainly occur around the western and northern parts of the country. In particular, the Cheshme Kabud rural district, which is located in the western part of Iran, is a region of frequent landslide occurrence as a consequence of inherent and triggering factors. As such, this study seeks to assess the accuracy of the different methods used to generate landslide susceptibility maps. This study also aims to predict the landslide extension to the existing areas in the future. The methods used for the generation of landslide susceptibility maps in the study were Moderation, Artificial Neural Network (ANN) and regressions (logistic, spatial and Geographically Weighted Regression (GWR)). Extension of the existing landslide areas was predicted using Geographically Altitudinal Weighted Regression (GAWR) method. In this study, GeoEye-1 and IKONOS satellite images were used for providing landslide inventory. Nine landslide conditioning factors namely slope, aspect, landuse, lithology, soil type, erosion, distance to roads, distance to rivers, and distance to faults were considered in the analysis. In Moderation method, all the classes of factors were weighted. In this way, the final weighted classes generated a landslide susceptibility map of the Chesme Kabud rural district. The lack of weather stations in the study area posed a significant limitation to the data collection, considering the effect of rain on landslide susceptibility mapping in the area for all the methods. By validating the three methods using the receiver operating characteristic (ROC) technique, the result showed that the Moderation method showed the best performance with a 95% prediction accuracy. The result of the GAWR indicates that, in general, the areas of small landslides will experience more extension than larger landslides in the future.

ABSTRAK

Tanah runtuh merupakan fenomena semulajadi yang kompleks yang menyebabkan kerosakan harta benda dan kehilangan nyawa di serata dunia. Sebagai contoh, di Iran, kebanyakan kejadian tanah runtuh adalah tanah runtuh cetek, berlaku terutamanya di sekitar bahagian barat dan utara negara ini. Khususnya, daerah pendalaman Cheshme Kabud yang terletak di bahagian barat Iran adalah kawasan yang banyak berlaku tanah runtuh akibat dari faktor-faktor sedia ada dan yang mencetuskannya. Dari itu, kajian ini bertujuan menilai ketepatan kaedah-kaedah yang berbeza dalam penghasilan peta-peta kecenderungan tanah runtuh. Tujuan lain kajian ini adalah untuk meramal perluasan tanah runtuh pada masa hadapan terhadap tanah runtuh sedia ada. Kaedah-kaedah yang telah digunapakai dalam kajian ini bagi menentukan kecenderungan terhadap tanah runtuh adalah Penyederhanaan, jaringan neural buatan (ANN), regresi (logistik, spatial dan regresi wajaran geografi (GWR)). Untuk meramal perluasan tanah runtuh sedia ada, kaedah yang telah digunakan adalah regresi julat-altitud wajaran geografi (GAWR). Dalam kajian ini, imej-imej satelit GeoEye-1 and IKONOS telah digunakan bagi menyediakan inventori tanah runtuh. Sembilan faktor pensuasanaan tanah runtuh seperti cerun, aspek, gunatanah, lithologi, jenis tanah, hakisan, jarak kejalan, jarak kesungai dan jarak kegelinciran telah diambil kira dalam analisis. Dalam kaedah Penyederhanaan, semua kelas-kelas bagi faktor-faktor diberi pemberat. Dengan cara ini, kelas-kelas akhir dengan pemberat telah menghasilkan peta kecenderungan tanah runtuh bagi daerah pendalaman Cheshme Kabud. Kekurangan stesen kajicuaca di kawasan kajian menyebabkan kekurangan yang ketara dalam pengumpulan data, mempertimbangkan kesan oleh hujan terhadap pemetaan kecenderungan tanah runtuh dalam kawasan kajian bagi semua kaedah. Dengan membuat penentusahkan terhadap ketiga-tiga kaedah, menggunakan teknik penerima operasi ciri (ROC), keputusan kaedah Penyederhanaan menunjukkan prestasi terbaik dengan ketepatan ramalan 95%. Hasil keputusan dari kaedah GAWR menunjukkan secara umumnya tanah runtuh bersaiz kecil akan mengalami perluasan tanah runtuh lebih banyak dari tanah runtuh bersaiz besar pada masa hadapan.

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LIST OF ABBREVIATIONS

AI	Artificial Intelligent
ANN	Artificial Neural Network
AUC	Area Under Curve
CAR	Conditional Auto Regressive
DEM	Digital Elevation Model
DTM	Digital Terrain Model
ENVI	Environment for Visualizing Images
ERDAS	Earth Resources Data Analysis System
ETM+	Enhanced Thematic Mapper Plus
GAWR	Geographically Altitudinal Weighted Regression
GCP	Ground Control Points
GIS	Geographic Information System
GPS	Global Position System
GSD	Ground Sampling Distance
GWR	Geographically Weighted Regression
IRS	Indian Remote Sensing
ISODATA	Iterative Self-Organizing DATA
LHZ	Landslide Hazard Zonation
LiDAR	Light Detection and Ranging
LR	Logistic Regression
LRA	Landslide Risk Assessment
LRA	Logistic Regression Analysis
LSZ	Landslide Susceptibility Zonation
MLP	Multi-Layer Perceptron
MLP	Multilayered Perceptron
NDVI	Normalized Difference Vegetation Index

NDWI	Normalized Difference Water Index
NDWI	Normalized Difference Water Index
OBIA	Object Image Analysis
PNN	Probabilistic Neural Network
RMSE	Root Mean Square Error
ROC	Receiver Operating Characteristic
RPC	Rationale Polynomial Coefficients
RRN	Relative Radiometric Normalization
SA	Sensitivity Analysis
SAR	Simultaneous Auto Regression
SAR	Synthetic Aperture Radar
SAS	Statistical Analysis System
SMA	Spatial Moving Average
SPOT	System Pour l'Observation de la Terre
SPSS	Statistical Package for the Social Sciences
SR	Spatial Regression
SR	Sensitivity Ratio
SSPC	Slope Stability Probability Classification
U.S. EPA	United States Environmental Protection Agency
UCU	Unique Condition Unit
VIF	Variance Inflation Factor

LIST OF NOMENCLATURES

R^2	-	coefficient of the determination of a regression
p	-	property of an even occurring
$\beta 0$	-	the intercept of the model
ε	-	vector of errors with zero mean and constant variance σ^2
w	-	proximity matrix
ρ	-	interaction parameter or spatial autoregressive coefficient
y	-	vector of observations on the dependent variable
β	-	parameter to be estimated due to relationship between the variables
Y	-	landslide occurrence
$\hat{\alpha}$	-	the vector of estimated parameters
X	-	the matrix of independent variables
$W_i(u)$	-	is the weight observed geographically and i is in relation to the u situation

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

A landslide is defined as "the movement of a mass of rock, debris, or soil down a slope" (Cruden, 1992). Failure of a slope occurs when the force that is pulling the slope downward (gravity) exceeds the strength of the earth materials that compose the slope. It can occur in the anywhere in the entire world except for extremely arid areas, land frozen permanently and all regions with less than a 5-degree slope angle (Muthu and Petrou, 2007).

Landslides are the world's third largest natural disaster that causes a lot of damage (Zillman, 2000). On the world scale, landslides cause billions of dollars in loss and thousands of deaths and injuries each year. Some countries suffer more damage; they lose about 0.5% of their gross national product per annum due to landslides (Chung, 1995). A landslide, which is a single slope slide, is mostly not as remarkable or costly as earthquakes, main floods, storms, or some other natural hazards. However, they are extremely widespread, and over the years may cause more things to be lost than any other geologic hazard. Besides, much of the destruction and sometimes a considerable proportion of the loss of life occurring with earthquakes and extreme storms are due to landslides (Varnes, 1984).

In June 1990, an earthquake in the north of Iran took about 37000 lives. Moreover, many people died in the landslide that was triggered by the earthquake from the Rudbar area that is located in the Gilan province. Even a village (Fatalak) was buried under thousands of tons of soil and all of people living in the village were dead. They could not even be dug out from under the soil for their funeral. Iran is mostly of a mountainous topography with tectonic activity, and is highly seismic with a sensitive geology and climatic conditions that are extremely susceptible for landslide occurrence. In most of Iran, landslides are a common disaster. Based on preliminary government estimation (2005) of the financial loss caused by landslides is about $126 billion. This was in addition to the loss of life, and injuries that occurred. Many landslides have occurred in Iran, of which the number of casualty was estimated to be about 32,000 lives (Government report, 2012).

Most of the landslide occurrences in Iran are shallow; but, tectonic landslides can also be seen in the zone of geology, which matches on the fault lineation. In areas near to the author's study area, (about 50 km distance) in the mid of April 2002, an earthquake triggered some landslides and rock falls which destroyed rural buildings, agriculture and grasslands. Nevertheless, in the author's study area, no landslides could be found that occurred due to the direct effect of the earthquake.

Landslides require proper planning for proper management and control. In landslide management, landslide detection is the first important step. The detection of landslide requires suitable knowledge about the current and future landslide occurrences. Landslide inventory records landslide occurrences using various methods. However, the exact date of occurrence of a landslide is difficult to ascertain. Notwithstanding, if the landslide is new, the date of occurrence can be estimated, even though it is difficult to determine the exact time of occurrence.

As such, in general, the landslide inventory can only map the type of landslide in terms of either new or old as well as in terms of the size of landslide. Various terms are associated with the prediction of future landslides. These include evaluation, assessment, zonation, sensitivity, vulnerability and susceptibility. There were various methods used by different authors with the objective to predict or estimate future landslide occurrence (Lee *et al*., 2002; Zhou *et al*., 2002; Wang *et al*., 2009; Neuhäuser *et al*., 2007; Van Westen *et al*., 2008; Dahal *et al*., 2008; Barbieri *et* *al*., 2009; Mathew *et al*., 2007; Pradhan *et al*., 2010; Cervi *et al*., 2010; Regime *et al*., 2010; Mezughi *et al*., 2011).

Other works such as (Anbalagan., 1992; Anbalagan *et al*., 1996; Süzen *et al*., 2004; Chau *et al*., 2004; Kanungo *et al*., 2006; Gupta *et al*., 2008; Chauhan *et al*., 2010; Singh *et al*., 2011) also predicted landslide spatially using such methods as landslide hazard zonation (LHZ) and landslide susceptibility zonation (LSZ) maps. In landslide zonation and inventory mapping, various algorithms and tools are utilized. These methods include both direct and indirect techniques which can be divided into statistics, heuristic (geomorphologic, physical (unit)), seasonal, event and data mining (neural network and fuzzy logic) (Domínguez-Cuesta *et al*., 2007; Nefeslioglu *et al*., 2008; Sato *et al*., 2009; Listo *et al*., 2012; Havenith *et al*., 2006).

“Direct” means that the researcher requires doing more investigations in the fieldwork for landslides. Most of the landslide’s identification and estimations are undertaken straight on the ground. The researcher needs to find some indicators from the field, such as a failure of rock and soil, water drainage types and other evidences of factors that can cause the acceleration of landslide occurrence. Indirect methods include the use of satellite images, aerial photographs, and base maps like topographic maps and lithology, which give aid to identify landslides and determine landslides (Van Westen *et al*., 2003; Yalcin, 2007; Bednarik *et al*., 2010; and Van Westen *et al*., 2008).

Researchers use devices and tools to accelerate and provide more accuracy in producing inventories and susceptibilities maps. These devices comprise Global Position System (GPS), satellite images, aerial photos and GIS software which have been used with regards to their access and are compatible with a condition of the environment (Kanungo *et al*., 2006; Herrera *et al*., 2009; Kaunda., 2010; Nichol *et al*., 2009; Gupta *et al*., 2008; and Alkevli *et al*., 2010, 2013). The algorithm is extremely valuable to assess landslide susceptibility. It shows a contribution and determines whether the research has anything in addition to previous work. Many researchers have used various algorithms regarding landslide susceptibility (Mora *et* *al*., 1994; Van Westen *et al*., 1993; Pachauri *et al*., 1992; Nilsen, 1979; Brab, 1972; Radbruch *et al*., 1982; and Anbalagan, 1992).

Algorithms are chosen in accordance with the achievement of the desired goals and objectives of the research. In summary, methods are a bridge between devices and algorithms. For landslide susceptibility, the use of practical and accurate algorithms is indeed vital. These algorithms are usually named after their inventors (Miles *et al*., 1999; Gupta *et al*., 1997). Sometimes, devices and methods are also considered as algorithms (Melchiorre *et al*.,2008; Saito *et al*.,2009; Pavel *et al*.,2008; Borgogno *et al*.,2009; Frattini *et al*.,2010; Yeon *et al*.,2010; Pradhan *et al*.,2010). In the current study, to best of author knowledge, a method called Moderation is proposed for the first time in the study of landslide susceptibility. The current study also employs methods such as the logistic and spatial regressions, Geographically Weighted Regression (GWR), Geographically Altitudinal Weighted regression (GAWR) and Artificial Neural Network (ANN) methods with some data acquired from devices satellite images and aerial photographs.

1.2 Problem Statement

Landslide is severe environmental hazards in mountainous areas (Zinck *et al*., 2001). This natural phenomenon constitutes a major destructive natural event striking civilian urban settlements and infrastructures, resulting to serious damages among humans the world over (Peyret *et al*., 2008); and constitutes a major cause of disaster in western Iran. Among the areas particularly prone to landslides are the sloppy areas, regions of heavy rain as well as poor vegetation.

Another region prone to landslides in Iran is the Cheshme Kabud rural district, which is also located in Western Iran. This district is part of the Kermanshah province, and has a land area of 250 km^2. The Cheshme Kabud rural district, due to its tribal structure and excessive pasturing behavior and stratum sensitive geology, is extremely susceptible to landslides.

Cultivation lands (agriculture lands) are more susceptible to landslide occurrence compared to rangelands or grasslands due to plowing (Figure 1.1 and 1.2). Cultivation specifically reduces the strength of the regolith, thereby making the slopes to be more susceptible to landslides. This is due to the fact that cultivated lands are covered by plants only during specific periods of the year (cultivation periods), while grasslands are usually covered across the entire year. Within the study area, some of the rangelands or pastures comprise of shrubs and scattered trees, both of which significantly contribute to the process of evapotranspiration and decrease soil water-holding capacity.

These trees, which also have high water consumption capacity and drainage, result in keeping the soil light. The tree roots, shrubs and small plants, especially root surfaces, help soil particles to bond together, thereby preventing the soil from slipping. Changes in land use from pasture and forest to cultivated lands may cause increasing landslide occurrences (Figure 1.3). In some parts of the study area, shallow and large landslides had occurred due to cutting of slope toes by running rivers (Figures 1.4 and 1.5), resulting in the generation of large quantities sediment and debris flows (See Figure 1.6).

Figure 1.1 Land use affected by landslide occurrence

Figure 1.2 Deforestation and changing land use in study area lead to landslide occurrence

Figure 1.3 Changing land use from range to cultivated land has cause landslide

Figure 1.4 Large landslide occurred, the consequence of cut of the slope toe by river

Figure 1.5 Removal of slope toe and occurrence of landslide

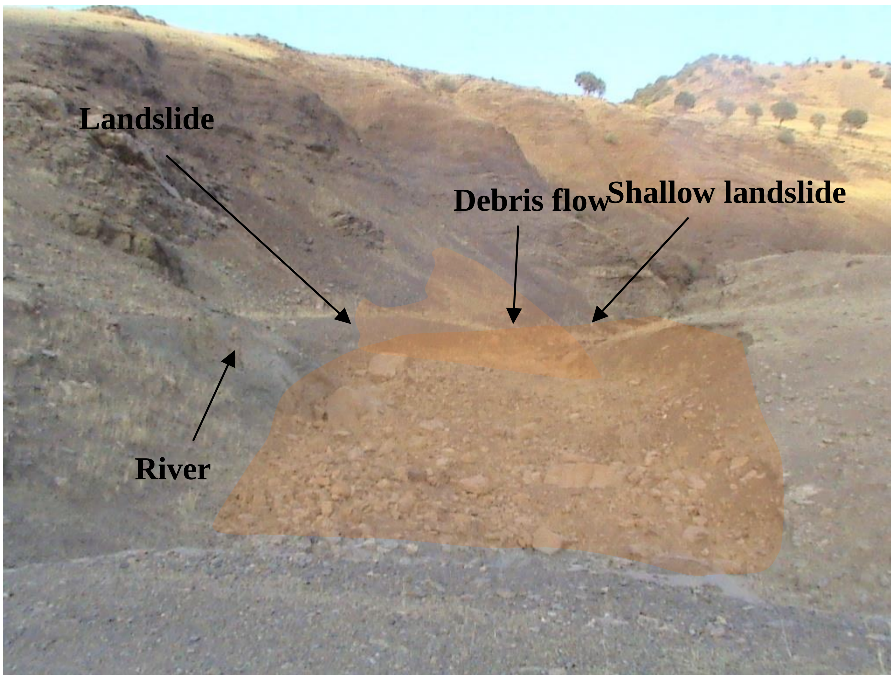

Figure 1.6 Debris flow in Cheshme Kabud

It has an average elevation of 1500 m above sea level. Instability of the area, damaged roads and natural resources were found in the study area. Deforestation due to human activities contributes to landslide occurrences. There are villages and farms that are located on unstable terrain; therefore, there is a need for the ability to help the people avoid danger by assisting them in the resettlement to a new place away from the hazardous region.

Numerous research works have been done on landslide susceptibility mapping for the last several decades (Guzzetti *et al*., 1999; Fourniadis *et al*., 2007; Kawabata *et al*., 2009; Pradhan., 2010) together with the proposal of various methods and algorithms for landslide susceptibility mapping. While the choice and scale of a landslide map depends on many factors, a primarily determinant of the choice of map is the requirements of the end user as well as the ultimate purpose of the investigation (Varnes, 1984). In the recent years, methods of landslide susceptibility mapping were shifted from physical to statistical and data mining with the help of GIS and remote sensing techniques**.**

Landslide susceptibility can be divided into two categories: qualitative and quantitative or direct and indirect. Qualitative methods are subjective and portray the hazard level in descriptive terms. Geomorphology mapping is an example of a qualitative and direct method. Quantitative methods produce numerical estimates (probabilities) of the occurrence of landslide phenomena in any susceptibility zone. Direct landslide susceptibility mapping involves mapping landslides within a given region by means of field studies, aerial photography interpretation or other methods (Yesilnacar, 2005).

Methods of qualities and quantities require the use of algorithms, which make them suitable for predicting precisely in most environments around the world. Algorithm may rely on specific assumptions that are compatible with real life conditions. For example, landslide never occurs in any slope less than 5 degree or 8 percent because of the weak gravity (solifluction and mudflow or other flows are not considered as landslides). However, many landslide susceptibility maps ignore this point, and as such, are unable to show surfaces that are sensitive to exact locations of landslide occurrence.

In spite of frequent landslide occurrences in the study area, this region does not have the landslide inventory and susceptibility maps. The most worrying of the landslides in the study area is that they have occurred near to villages. This problem is a high risk problem, especially in the South East of the area where numerous villages are located in a linear form are prone to landslide and flood hazards. Exact inventories that map the determine locations of past landslides in the region will give knowledge about sites and places of these landslides, which will give aid to understanding future events (Guzzetti *et al*., 2012). A landslide inventory will help researchers to select more and precise parameters that will most probably affect landslide occurrences (Korup, 2004). Therefore, if one can identify landslides, it can help to control, mitigate or prevent the landslide hazards.

The author has suggested a Moderation method that can consider all influencing factors as moderation for all other factors, to produce a landslide map, together with two other methods: several regression methods and neural network. Then, the author compared the results with existing landslides. Before that, a landslide inventory was produced using high-resolution satellite images (Ikonos, GeoEye), aerial photography (1:20,000), GPS and fieldwork.

1.3 Aim of Study

To evaluate the accuracy of different methods of landslide susceptibility.

1.4 Objective of Study

i. To determine the best Moderation model of predicting landslide occurrence based on existing landslides.

ii. To compare the accuracy of Moderation, regressions and Neural Network methods for landslide susceptibility.

iii. To investigate the capability of Geographically Altitudinal Weighted Regression (GAWR) method for predicting the area extends of existing landslides in the future.

1.5 **Research Question**

1- What is the best Moderation model to predict landslide occurrence?

2- Which one of the three methods: Moderation, regressions and Neural Network has the best reliability and accuracy for landslide susceptibility?

3- Can the GAWR method be used to predict the area extent of existing landslide area?

1.6 Scope of Research

In this study, methods and devices for mapping single landslides, or clusters of slope failures have not been considered since the priority has been on a regional scale. Generally, for the single landslide study, it always involves monitoring or a geotechnical survey. The methods and techniques used in this research were for mapping the surface characteristics of shallow landslides (soil slide). Other slides and topples including mud fall; rock fall and flow were not considered in this study even for susceptibility mapping.

This research has been to assess and estimate places that are susceptible to landslide. Therefore suitable tools, methods and algorithms were necessary. Images of GeoEye and Ikonos had a coverage of about 85% of the region and were used in this research. Although, there are not a large number of landslides in the remaining of the study area (15 percent), but the remaining area was investigated by fieldwork; also, by using Cartosat 1 images (pan 2.5 resolutions).

Nine parameters were used to produce landslide susceptibility including lithology, Land use, soil, proximity to river, road, and fault, aspect, erosion and slope. Although rain is particularly influential to landslide occurrence, in this study, it was ignored because there were no weather stations in this area.

To calculate and prepare landslide susceptibility with neural network, three data that contained training, testing and validation data were collected. In fact, training data included stable and instable areas. Whilst, testing data consisted of some points selected from all of the landslides. The back-propagation algorithm was used to calculate input and hidden layers, which was carried out by using Matlab software programming.

1.7 Significance of Study

Landslide susceptibility mapping is one of the important strategies for landslide management. The landslide susceptible maps provide essential knowledge of landslide susceptibility situation of a certain region, which is useful for the community in planning, mitigating and avoiding the danger of landslides. On the other hand, landslide susceptibility maps of a specific site are prepared not only for landslide monitoring but also for delineating areas requiring mitigation measures.

The study area does not have any landslide map and other hazard maps, therefore, the production of landslide inventory and susceptibility maps will serve as important aids for decision makers and the government in the monitoring and control of present and future landslides. In addition, some parts of the study area face problems associated with sediment drive from landslides, which have negative effects, such as direction shift, on the main river in the region.

One of the significant impacts of landslides is the destruction of grassland areas for pasture. These grasslands are critically used by nomadic farmers and villagers for their cattle and livestock. Landslide susceptibility shows the situation of this type of phenomena as well as the associated hazard, which aid the government in the drive towards sustaining such slopes sensitive to landslides. Landslide susceptibility shows the most susceptible areas to landslide.

Nowadays, there exist plenty of crucial accessible data, including very high-resolution images from which can be prepare more accurate landslide inventory and susceptibility maps. Here, the Moderation method is one of the suitable techniques that can be employed for estimating the regions prone to landslide. The Moderation method is particularly suitable for landslide mapping given its ability to identify the factors with the most impact on landslide occurrence. As regression methods can predict future changes in landslide given landslide occurrence changes in the past, as well as their ability to measure the effect of these influencing factors on landslide, the GAWR is one of the most utilized techniques to that effect. The GAWR method is a powerful regression technique used for this correlation at the local scale, and also uses account altitudinal coordinates for predicting the extent of the existing landslide area. As such, the GAWR technique is applied in the current study for predicting the area extent of landslide, which can be constant, decreasing or increasing in area with reference to future landslides.

1.8 Subject of the Study

The subject of the study is shallow landslides, which usually comprise of soil, young soil and debris. This type of landslide is usually divided into rotational and transitional forms. Topple, rockfall, creep and earth flow are not investigated in this study because they do not have characteristics or share similar conditions with landslide occurrence. Based on fieldwork, most of the landslides that were observed are close to villages, rivers and roads.

Moreover, landslides have occurred in several parts of the research area where there are land use changes ranging from forest to cultivated and agricultural lands. Hummocky land is more sensitive to shallow landslides than the plain and mountainous parts of the area. This part of the area is located in the South of Cheshme Kabud rural district. There are a numerous of landslides of different ages criterion such as dormant, old and new landslides. Nevertheless, in the recent years, the numbers of new landslides have fallen due to reduced rainfall.

The shallow landslides are different in depth and size, but these attributes are very similar among shallow landslides compared to deep-seated landslides. Some parts of the area (Northern) have been explored for mining. Consequently, it was observed that this human activity created artificial landslides. Therefore, these landslides are negligible and not considered in landslide inventory and susceptibility preparation in this research.

Since high-resolution images (Ikonos and GeoEye) are available, the scale of landslide susceptibility produced can be 1:10,000. Nevertheless, this scale is not adequate for slope stability analysis given the fact that even shallow landslides are neighboring to each other. Therefore, a group of landslides rather than a single landslide is considered in this research.

1.9 Study Area

The study area lies between latitude 34° 05' 00"N and 34° 13' 00"N, and longitude 47° 13' 00"E and 47° 22' 00"E, and covers an area of 250 km^2. The geology is the study area is limestone. The terrain is characterized by rugged topography, steep rocky slopes at higher elevations, and mountain peaks more than 600 m above the ground. Gentle to moderate slopes at low and mid elevations are typically mantled by deposits that range in texture from clays and silts to coarse gravels.

Slopes are commonly steeper than 25%, with steepness generally increasing with elevation. Bedrock consists primarily of limestone and radiolarite rocks. Climate is generally semi-arid (Mediterranean) characterized by hot dry summers and mild wet winters. However, temperature and precipitation are significantly influenced by elevation. The mean annual air temperature varies from 14.3 °C to 15.9 °C. The average annual precipitation is about 400 mm, with a daily maximum of 53 mm.

1.10 Overview of Thesis

The structure of the thesis is divided into five chapters. The description of each chapter is as follows:

Chapter 1 provides the introduction of the study. This chapter includes the background of the study including definitions and types of landslides, the effects of landslides in the study area, regions generally damaged by landslides, methods of susceptibility and assessment of landslides, data and algorithms used for evaluating landslides. The chapter also contains the problem statement, scope, aim and objectives as well as the significance of the current study.

Chapter 2 focuses on the literature review of previous related researches, theories and as well as practical implementations. The review includes the history of the landslide inventory and susceptibility mapping by the various researchers whom used different models and algorithms for the attainment of results.

Chapter 3 provides the description of the study area as well as the research methodology of the current study. This chapter illustrates in detail the regression methods (logistic, spatial, Geographically Weighted Regression and Geographically Altitudinal Weighted Regression), Artificial Neural Network as well as the Moderation methods.

Chapter 4 presents the result and analysis of the current study. This chapter also illustrates the accuracy assessment of the results. In chapter 5, the thesis is concluded, and the recommendations for future work stated.

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